

## Appendix

coupling, particularly in systems where many devices share a common channel. However, in systems where only a small number of devices are coupled together, tighter coupling may be desired to reduce attenuation between devices and reduce undesirable radiation. For example, tighter coupling may be appropriate in systems having eight or fewer electronic devices electromagnetically coupled to a transmission line.

[0042] Table I below summarizes three link budget analysis applicable over a broad range of operating conditions for the embodiment illustrated in Figure 3 above, given the following exemplary parameters. A carrier frequency in the range of 1-10 GHz is assumed, and electromagnetic couplers 18 are about 2-3 millimeters long and about 50 microns above shielding plane 46. Insulating layers 36 and 38 together are about 25 microns thick. Transmission line 22 is about 150 micron wide, spaced about 150 microns from shielding planes 46 and 48. It should be stressed that the above dimensions are exemplary only and given as the framework setting for the below described exemplary link budget analyses. The invention is not limited in any way to the above described dimensions or the below described operating ranges.

[0043] Exemplary case #1 through case #3 of table I represent decreasing system cost and complexity at the expense of decreasing data rate performance.

[0044] The Noise power  $N_i$  in milliwatts is given by the formula:

Where:

$$k = 1.38 \times 10^{-23} \text{ Joules/Degree}$$

(Boltzmann's constant)

$$T_e = F_1 T_m$$

## Appendix

scheme in a modest implementation. More complex modulation schemes and circuitry are capable of yielding higher bits / Hz densities. Likewise, spread spectrum techniques can yield lower bit / Hz densities while yielding lower bit error rates at lower SNR ratios at the expense of additional system complexity.

**[0047]** Exemplary case # 1 represents a link budget where the system transmitter voltage (e.g., transceiver 16 of Figure 4) is 2.4 volts peak-to-peak into a 50 ohm (+11.6 dBm), an 18 dB transmitting electromagnetic coupler 18 loss is used, the receiving electromagnetic coupler 18 has an additional 18 dB loss, and the Printed Circuit Board (PCB) and other system losses total 6 dB. In this case the desired link margin is 10 dB and the desired signal to noise ratio (SNR) is 25 dB. A conservative receiver implementation noise figure of 8 dB is assumed. Hence, the available noise bandwidth is over 10 GHz, corresponding to a 3 Giga-bit / second (Gb/sec) data rate at 0.3 bit per Hz of bandwidth. In this case, the signal level power would not necessarily be a limiting factor of the implementation.

**[0048]** Exemplary case # 2 represents a link budget where the transmitter voltage is reduced 6 dB to 1.2 volts peak-to-peak into a 50 ohms (+5.5 dBm), along with a more lossy 22 dB transmitting electromagnetic coupler 18, together with the receiving electromagnetic coupler 18 has, representing an additional 22 dB loss. The link margin of case # 2 has been decreased to a still conservative value of 8 dB. The noise figure of the receiver implementation has been increased to 9

the available noise bandwidth is 1.6 GHz, corresponding to a 480 Mb / second (Mb/sec) data rate assuming 0.3 bit per Hz of bandwidth.